



RCA INSTITUTES

INC.
formerly
MARCONI INSTITUTE
Founded 1909



Technical Lesson 45

GENERAL ELECTRIC MODEL H-31 — WESTINGHOUSE MODEL WR-5

RADIOLA MODEL 80 — GRAYBAR MODEL 700

INTRODUCTION. These models are nine-tube a-c operated screen grid super-heterodyne radio receivers. The electrical specifications of these various models are the same; they differ only in cabinet design. Included in the cabinet is an improved dynamic type reproducer unit which, together with the receiver, gives a quality of reproduction closely approaching the original. A feature of these sets is the calibrated kilocycle dial. This dial is fairly accurate as to the divisions on the scale and a station will always appear around or about its correct kilocycle marking on the dial. This greatly facilitates the location of stations of known frequency even though they have not been previously received.

A local-distant switch is provided which, in addition to providing two different degrees of sensitivity, changes the selectivity of the receivers. At the local position the receivers are less sensitive and less selective, but have a better high frequency response. At the "distant" position of the switch the selectivity is increased with a slight loss in tone quality. This selectivity allows distant stations to be logged easily and gives ten-kilocycle separation on most stations at any frequency in the broadcast spectrum.

These sets use four 224 tubes, two 227 tubes, two 245 tubes and one 280 tube. Excellent sensitivity, selectivity, and tone quality are secured through the use of these tubes together with a large power output. The output is about 3 watts which approaches that of a 250 tube.

Electrical Specifications

Voltage Rating	105-125 Volts
Frequency Rating	50-60 Cycles, or 25-40 Cycles
Power Consumption.....	110 Watts
Recommended Antenna Length.....	25-75 Feet
Type of Circuit	A-C Screen-Grid Super-Heterodyne
Type and Number of Tubes	4 UY-224, 2 UY-227, 2 UX-245, 1 UX-280
Number of Radio Frequency Stages	1
Type of First Detector	Tuned Input Grid Bias
Number of Intermediate Stages	2
Type of Rectifier	Full Wave, UX-280
Type of Second Detector	Power Grid Bias
Number of Audio Stages	1 (Push-Pull)
Type of Loudspeaker	Dynamic
Wattage Dissipation in L.S. Field	10 (110 V. 85 M.A.)
Undistorted Output	3.0 Watts

of an average good receiver. The output of this stage is coupled capacitively to the grid circuit of the first detector or mixing tube by means of a small condenser. The plate circuit of the r-f stage has a high inductance coil which provides a high impedance, into which it is necessary to have the tube work in order to get good amplification.

At this point the oscillator should be considered, as its output is coupled also to the grid coil of the first detector. Its output, however, is inductively instead of capacitively coupled to this circuit. This is a tuned grid circuit oscillator using a 227 tube and having a closely coupled plate coil that gives sufficient feed-back to provide stable operation. The grid circuit is so designed that by means of a correct combination of capacity and inductance a constant frequency difference between the oscillator and the tuned r-f circuits throughout the range of the receiver is obtained.

The next circuit to examine is the first detector. The circuit is tuned by means of one of the gang condensers to the frequency of the incoming signal. In the grid circuit there is present the incoming signal and the oscillator signal, the latter being at a 175 kilocycle difference from the former. The first detector is biased so as to operate as a plate rectification detector and its purpose is to extract the difference or beat frequency, produced by combining the signal and oscillator frequencies. The beat frequency of 175 kc appears in the plate circuit of the first detector which is accurately tuned to 175 kc. The tube used as a first detector is a 224.

The next two circuits are the first and second intermediate stages which give a very high degree of amplification. The grids and plates of both stages, as well as the plate circuit of the first detector and the grid circuit of the second detector, are tuned to 175 kc.

Two resistances are arranged for connecting to the first intermediate frequency transformer, the connection or disconnection of which constitutes the action of the "local-distant" switch. At the "local" position a 40,000 ohm resistor is connected across the primary of this transformer and a 500 ohm resistor in series with the secondary and one side of the tuning condenser. The effect of these resistors is to decrease the sensitivity, broaden the selectivity and thus improve the fidelity of the set. At the "distant" position the resistance is out of both circuits and the original sensitivity and selectivity is obtained. After the high amplification in the intermediate stages, the signal appears in the grid circuit of the second detector.

The second detector is a high-plate voltage, grid-biased type detector which gives sufficient output to drive two 245 tubes connected in push-pull without an intermediate audio stage. The purpose of the second detector is to extract the audio-frequency component of the r-f signal which represents the voice or musical modulations produced in the studio of the broadcasting station. The audio component is extracted and used to drive the power tubes while the r-f current is by-passed and not used any further.

Figure 2 is a top view of the receiver assembly and shows the parts located thereon. Figure 3 is a bottom view of the receiver assembly and shows such parts as are located there.

SOCKET POWER UNIT. The socket power unit, Figure 4, contains all the parts used in the rectifier and power amplifier circuits together with the reproducer unit. This makes for unit construction and easy assembly, together with efficient operation.

The power stage comprises two 245 tubes connected in push-pull. These tubes give a large undistorted output which is delivered to the cone coil of the dynamic type loudspeaker by means of a center-tapped primary step-down transformer connected in the plate circuit of the 245 tubes. The primary impedance is of a value to match the plate impedance of the two tubes, and the secondary of a value that matches the cone coil of the reproducer unit. Thus, the full output of the two 245 tubes is efficiently applied to the loudspeaker.

In the grid circuit of the input transformer, a 60,000 ohm resistor is connected in series with the center tap of the interstage transformer. The purpose of this resistor is to eliminate audio oscillations.

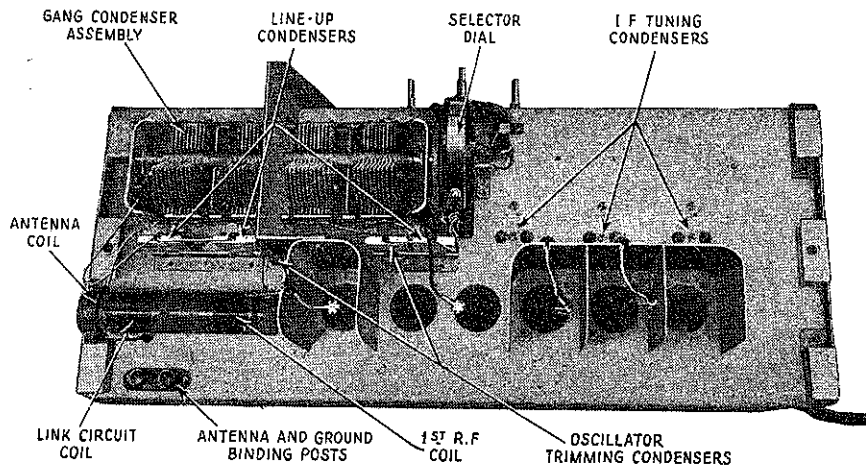


Figure 2

The rectifier is a 280 tube which provides a full wave rectifying device of ample capacity for providing all plate and grid voltages used in the receiver and power amplifier, as well as power for the field of the reproducer unit. A specially designed filter system removes all ripple from the d-c output of the rectifier. This results in the receiver having no a-c hum or other extraneous noise other than that picked up in the antenna system.

The reproducer field is used as a reactor in the filtering system, thus receiving its energy and acting as a unit in the filtering system at the same time. Figure 5 is a view of the bottom of the socket power unit.

As the filtering system in this receiver is somewhat different from the usual arrangement a word of explanation may help the serviceman to properly understand its action. Figure 1 shows the first stage of the filter having two condensers and a tapped reactor. The condensers function in the usual manner, acting as reservoirs to hold the current from one impulse to the next. The tapped reactor functions somewhat different from the usual manner, however. The d-c current flows through one section of it, the other section being connected to a condenser. However, an a-c voltage is present across the

other section due to its transformer action, similar to an auto-transformer. This voltage is 180 degrees out of phase with the ripple voltage across the second condenser and therefore to a large extent cancels out all ripple flowing from the tap to succeeding circuits. This results in the output of this section of the filter being substantially free from ripple. The field of the reproducer unit is connected in series with this output and further removes the slight ripple voltage remaining. The condensers are of ample capacity, being one 2 mfd. and two 3 mfd. in capacity, respectively.

A single filament winding on the power transformer provides all filament and heater voltages used, with the exception of the 280 tube which has a separate winding. It also supplies current to the dial lamp.

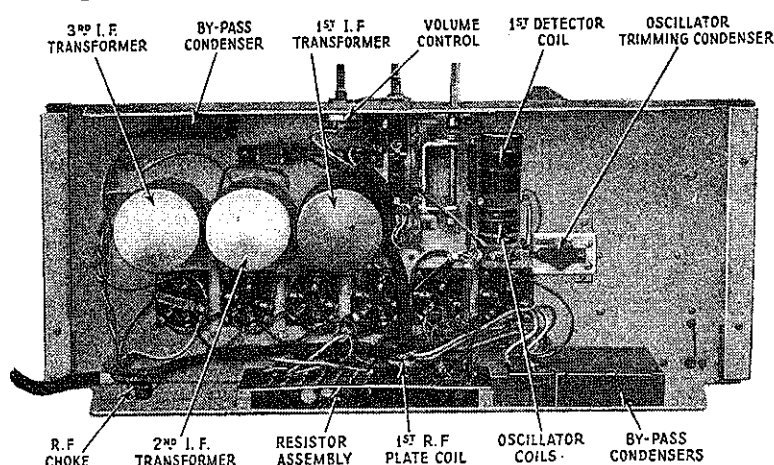


Figure 3

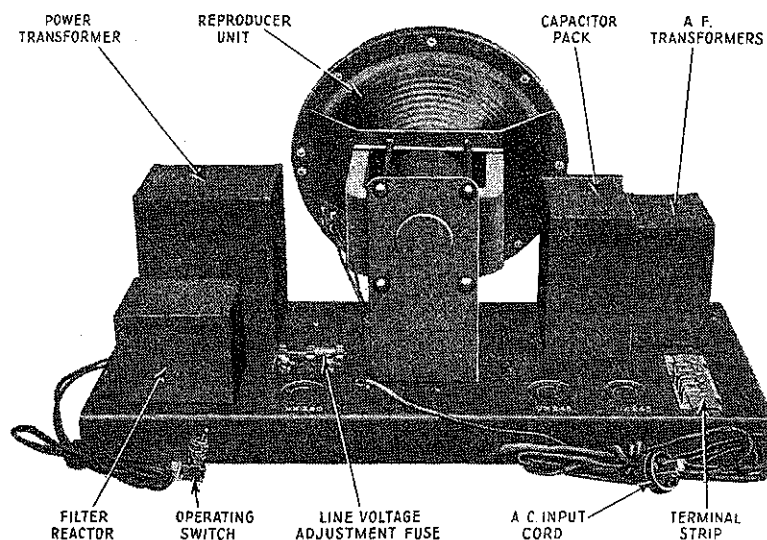


Figure 4

In addition to the 50-60 cycle models, 25-40 cycle models are also available. The difference between the 50-60 cycle and the 25-40 cycle receivers is the power transformer and an additional filter capacitor that is shown in Figure 1.

ANTENNA (Outdoor Type). Due to the high sensitivity of these receivers the antenna length need be only 25 to 75 feet. In remote districts this length may be extended to secure improved pick-up of distant broadcasting stations.

The antenna should be erected as high as possible and be removed from all obstructions. The lead-in should be a continuation of the antenna itself, thus avoiding all splices which might introduce additional resistance and, in time, corrode sufficiently to seriously affect reception. If it is absolutely necessary to splice the lead-in to the antenna the joint must be carefully soldered to insure a good electrical contact. Clean off all excess flux and tape the connection, to protect it from the oxidation effects of the atmosphere.

High grade glass or porcelain insulator supports are required, and at no point should the antenna or lead-in wire come in contact with any part of the building. Bring the lead-in wire from the outside through a porcelain tube or other approved insulator to the inside of the house for connection to the receiver.

The antenna should not cross either over or under any electric light, traction or power line and should be at right angles to these lines and other antennas. An outdoor antenna should be protected by means of an approved lightning arrester, in accordance with the requirements of the National Fire Underwriters' Code.

ANTENNA (Indoor Type). Where the installation of an outdoor antenna is not practical, satisfactory results may generally be obtained by using an indoor antenna of 25 to 50 feet of insulated wire strung around the picture moulding or placed under a rug. In buildings with steel framework or where metal lathing is employed, satisfactory results are not always possible with this type of antenna. However, due to its sensitivity, this instrument will generally give entirely satisfactory reception with an indoor antenna.

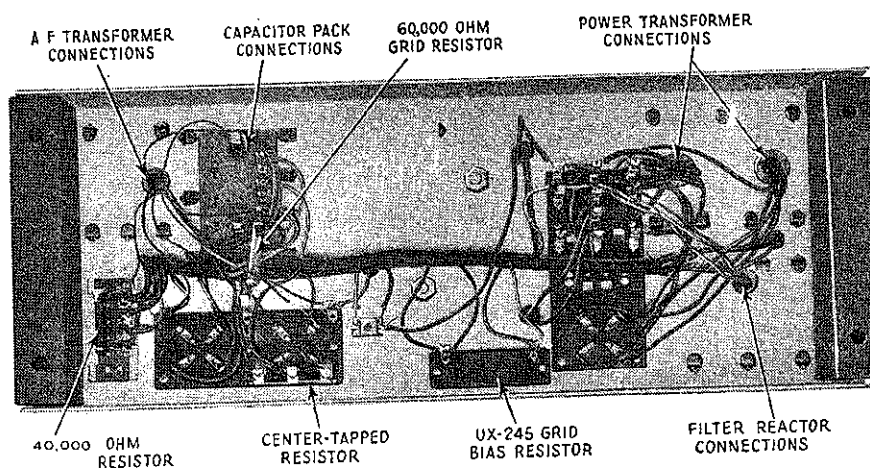


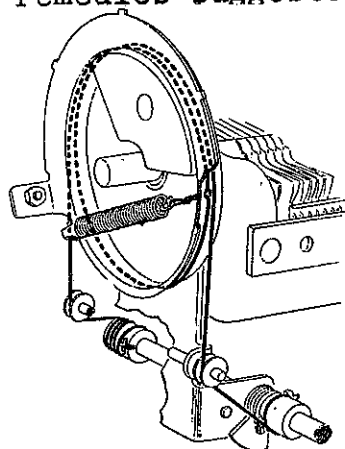
Figure 5

SPECIAL ANTENNA INSTALLATIONS FOR NOISY LOCATIONS. In line with other receivers, when these sets are installed in some city locations, such as apartment houses, hotels and office buildings, it is possible that the level of noise compared with the signal strength of the desired station may be such that the station cannot be received without an objectionable noise background. This noise may be defined as inductive interference from electrical devices such as elevator motors, generators, violet ray machines, professional equipment, etc. It may have no apparent radio-frequency peak, or it may have a broad peak. The effect of the noise may be divided into the following three general classes:

1. Where the noise level is zero with no antenna or ground, but is equally great on either an indoor or outdoor antenna.
2. Where the noise is equally great with the antenna and ground either connected or disconnected.
3. Where the noise level is greater when the outside antenna is connected than when an inside antenna is used; the inside antenna, however, not giving sufficient pick-up for satisfactory reception.

In (1) where the noise level is zero with no antenna or ground connected, but equally great with either an indoor or outdoor antenna, it is at once apparent that the interference is not being brought into the receiver over the power supply lines. It has been found in such cases that an antenna five feet long inside the room picked up as much noise as when an entire outside antenna lead-in were used. This indicates that the noise is within the building and, in the case of the outside antenna, is being picked up on that portion of the lead-in that enters and goes through the building. In such cases the receiver should be located close to the point where the outside lead-in enters the building. If this is impractical the receiver can be placed in any location and a copper braid placed over the inside portion of the lead-in wire. This braid is not grounded. If the noise level is still appreciable a good receiver ground with a short lead may be obtained. A long lead is not desirable, as it may pick up noise. Placing a shield over the ground wire, but not grounding the shield, may help.

In (2) the noise is picked up with no antenna or ground connected to the receiver. This indicates the noise is entering the receiver through the power lines. In this case filters must be placed in the power supply at the source of the noise or at the receiver, depending on conditions. If the trouble is cleared up in this manner when the antenna and ground are disconnected, but again appears with the use of the antenna system, the remedies suggested in (1) must also be applied.



Condenser drive cord arrangement
Figure 7

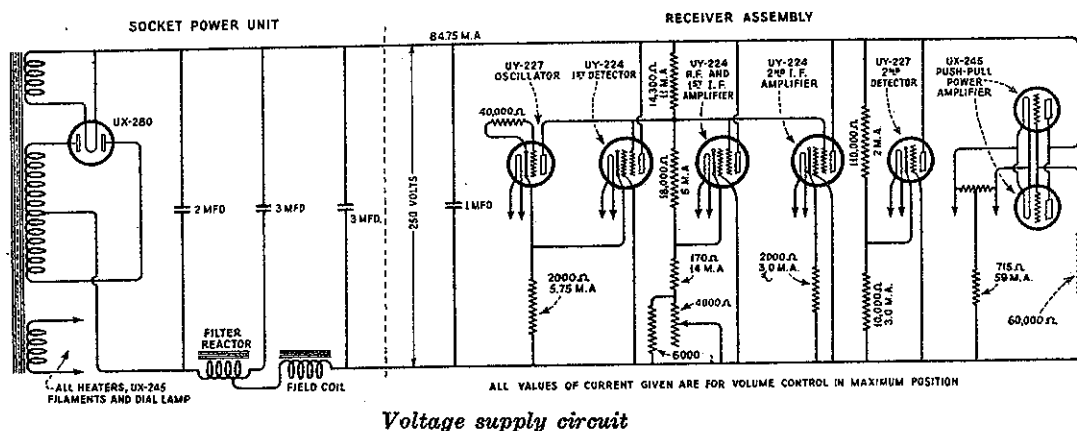


Figure 8

In (3) the noise is greater when the outside antenna is connected than when an inside antenna is used. The use of the inside antenna, however, does not give sufficient pick-up for satisfactory reception. In this case the pick-up is probably occurring on the lead-in wire between the receiver and the antenna. Copper braid should be placed over the entire lead-in from the receiver to the flat portion of the antenna. Also changing the direction of the antenna should be tried and the lead-in connected from the end of the antenna that gives the best results. The copper braid may or may not be grounded — best results being determined by experiment. The conditions existing in any locality must be analyzed and placed in its correct category. A little patience and experimenting will usually result in a satisfactory installation.

GROUND. A good ground is quite as important as a good antenna. No specific recommendations can be given in this matter as conditions vary in different locations. Water and steam pipes usually make good grounds. Gas pipes make poor grounds and, as a rule, are to be avoided. If neither water nor steam pipes are available, a pipe or metal rod may be driven into the ground to a depth of several feet. The success of this type of ground depends upon the moisture present in the soil. The ground lead should be as short as possible and connected by means of an approved ground clamp to a section of pipe that has been scraped and thoroughly cleaned. The connection should be inspected from time to time to make certain that a clean and tight electrical contact exists between the clamp and pipe. The serviceman should experiment with various grounds, and employ the one giving the best results.

VACUUM TUBES. This set uses nine vacuum tubes, four 224's, two 227's, two 245's and one 280. The tubes should be placed in their correct sockets as shown in Figure 6. After placing the receiver in operation it is best to try interchanging the tubes in the following manner so as to get the best results from a given set of tubes. Always turn the operating switch "Off" before removing a tube.

1. Interchanging the two 227 tubes and leave the one in the oscillator socket that gives the loudest signal at a given position of the volume control. If another 227 tube is available try interchanging it with the one in the detector socket and turn the volume up to its maximum output. Use the tube that gives the greatest undistorted output.
2. The 224 tubes should be tried in the first detector and first r-f stage until those giving the loudest signal on a given station with the same setting of the volume control are found. The remaining tubes should be placed in the two intermediate stages. The two 245's are placed in the push-pull stage and the 280 in the rectifier socket.

LOCATION OF RECEIVER. The receiver should be tried in various locations in the room in which it is to be operated and the location giving the best acoustical results used. However, the eight-foot a-c cord may prove a limiting factor if an a-c outlet is not within its radius. An extension cord may be used in cases of this kind as the better results usually justify its small cost.

The antenna and ground leads should be separated as much as possible until they connect to the receiver, otherwise a reduction in signal strength will result due to the capacity between leads.

ADJUSTMENT FOR LOW LINE VOLTAGES. A fuse is provided in the primary circuit of the power transformer which, in addition to acting as a protective device, allows proper adjustment to be made for lines having different voltages.

The fuse is so placed at the factory that the set will give normal results on a-c lines of 115 to 125 volts. If the line is always less than 115, the set may be adapted to it for best results in the following manner:

1. Remove the cover over the fuse by loosening its retaining screw and lifting clear. Underneath the cover will be seen three fuse clips with a small cartridge fuse inserted between two of them. See Figure 6. One outside clip is marked 110 and the other 120. In its original position the fuse is placed between the center one and the one marked 120.
2. Lift the fuse from its original position and insert it between the clip marked 110 and the center clip.

So connected the set will give best results on lines not exceeding 115 volts. To replace a fuse, remove the cover and old fuse and place the new fuse in the same location. Then replace the cover.

BLOWN FUSE. A blown fuse may be caused by the following:

1. Connecting the set to the d-c line.
2. Plate to plate short of 280 tube.
3. Shorted condenser in capacitor pack.
4. Shorted filament or heater contacts or dial lamp socket.
5. Defective power transformer.

Any of the above causes must be cleared up before a new fuse is installed, otherwise the new fuse will blow as soon as the old one is replaced and the power turned "On."

JERKY ACTION OF STATION SELECTOR. Should operation of the station selector be stiff or jerky a little oil dropped on each condenser bearing will effectively remedy this condition. When experiencing this trouble it is also well to check the cable tension spring to make sure that suitable tension is being applied to the condenser drive cable.

USE OF "LOCAL-DISTANT" SWITCH. The "local-distant" switch in the receiver performs a somewhat different function from the usual local-distant switch used in other receivers. At the local position the receiver is still very sensitive, but its selectivity is impaired slightly in order to get better tone quality. The set should normally be operated with this switch in the "local" position. In the "distant" position better sensitivity and selectivity is obtained, and throwing the switch to this position will give better volume on extremely weak signals and on all signals the frequency of which is but slightly different from powerful local stations. The difference in tone quality of the two positions of the switch while noticeably better at the local position is still very good at either position. At times when the noise level is high, throwing the switch to the "distant" position, even when receiving a local station, may give better results.

PRECAUTIONS FOR EXCESSIVELY LOUD SIGNALS. In some locations, very close to extremely powerful stations, it may be advisable to place a switch in series with the antenna and disconnect the antenna when receiving such stations. If the volume control does not give proper cut-off from such stations remove the 6000 ohm resistor shunted across it. This may be done without removing the receiver from the cabinet by using a small pair of side cutting pliers. In some cases under such conditions it may be necessary to interchange the r-f and first intermediate frequency tubes.

ANTENNA SYSTEM FAILURES. A grating noise may be caused by a poor lead-in connection to the antenna, or the antenna touching some metallic surface such as the edge of a tin roof, drain pipe, etc. By disconnecting the antenna and ground leads the serviceman can soon determine whether the cause of complaint is within or external to the receiver and plan his service work accordingly.

TUBE SOCKETS AND PRONGS. The tube sockets used in this set are of an improved type having a large contact surface and should require a minimum of service work. In order to get best results, however, the tube prongs should be periodically cleaned because dirty prongs often cause noisy operation. Fine sandpaper may be used to clean them so as to insure a good contact surface. The use of emery cloth or steel wool is not recommended. Before re-inserting the tubes in their sockets wipe the prongs and base carefully to make certain that all particles of sand are removed.

NOISY VOLUME CONTROL. Noisy operation of the volume control is usually caused by dirt between the resistance element and the contact arm. Turning the volume control back and forth several times will usually clear the trouble. If it does not, however, the use of a pipe cleaner and one of the various cigarette lighter fluids, using the pipe cleaner to apply the fluid to the resistance element, will usually clear up the trouble. If neither of these remedies clears the trouble, the volume control must be replaced.

BROKEN CONDENSER DRIVE CORD. The gang condenser is driven from the station selector knob by means of a cord arrangement that also functions as a vernier control. This cord is of rugged construction and a spring is used to maintain an even tension at all times. Should the cord become disengaged from the drum or a new cord be required follow the arrangement indicated in Figure 8 for the correct position of the cord on the drum, otherwise the cord length will be incorrect or the stops on the shaft will engage at the wrong time.

EXCESSIVE HUM. Excessive hum may be caused by:

1. Defective 280 tube. Replace with one in known good condition.
2. Defective filter reactor. A filter reactor with shorted turns, or one in which the center tap has become open will cause hum in the loudspeaker.
3. Open filter condenser. An open of any of the filter condensers will cause a hum to develop.
4. Defective field coil in reproducer unit. As the field coil of the reproducer is a part of the rectifier filter supply, shorted turns or a grounded coil may cause hum. Any defective part must be repaired or replaced.
5. Grounded or shorted by-pass condensers. Test all condensers and replace any condenser found defective.
6. Defective center tapped resistance. A short of one section or any open in this resistance will cause a loud hum.

7. Grounded filament lead. This may occur at the S.P.U. (socket power unit) terminal strip due to the screw that holds the cover in place touching one filament lead.

ACOUSTIC HOWL. Acoustic howl may be caused by:

1. Defective rubber cushions. If the cushions on which the chassis is supported has become aged or hardened, they should be replaced.
2. Any defect in the support of the chassis that prevents it from being entirely supported by rubber may cause acoustic howl.
3. Microphonic detector tube. A microphonic tube, while rare, in the detector socket may cause a howl. The remedy is to replace the tube or use it in another socket.

LOW VOLUME. Low volume may be caused by:

1. Defective tubes. Try interchanging all tubes with other of similar type known to be in good condition.
2. Poor antenna system.
3. Receiver not properly aligned. First, replace the oscillator tube. Second, adjust oscillator trimming condensers, intermediate frequency tuning condensers, and gang condenser vanes.
4. Defective a-f transformer. The a-f transformers, the internal connections of which are shown in Figure 15, are in a metal container. All coils should be tested for continuity and if other defects are considered likely, the coils should be measured for d-c resistance. Shorted turns may be disclosed by substituting an entirely new unit for the one in use.
5. Low voltages from S.P.U. Measure all voltages and if low, replace the 280 tube or any defective parts that are causing low voltages in the S.P.U.
6. Open, shorts or grounds in receiver assembly. Test with continuity tests and make any repair or replacement necessary.
7. Shorted field coil in reproducer unit. Any defect that reduces the strength of the magnetic field of the reproducer unit will reduce the output of the receiver. Check the current (85 M.A.) in the field and the voltage drop (110 volts) across it. An open field coil will cause the receiver to be inoperative.

DISTORTED REPRODUCTION. Distorted reproduction may be caused by any of the following:

1. Vacuum tubes. A defective tube will cause distortion and can be defective even though it lights. Defects other than heater

or filament failures are checked only by substitution with a tube of known quality or by testing the tube.

2. Defective a-f transformers. An open in the secondary of the input transformer or shorted turns in any winding may cause distortion. Test by means of continuity or resistance measurement tests and make replacement if necessary.
3. Oscillation in receiver assembly. Oscillation in the receiver assembly other than that of the oscillator will cause distortion to be experienced with tuning in a station. This distortion will be accompanied by a whistle when the station is tuned in.
4. Receiver improperly aligned. Improper alignment of the receiver in addition to affecting its sensitivity and selectivity, will cause distortion of any signal received.
5. Incorrect tuning. If the receiver is not accurately tuned to the station being received, distortion will result. Follow instructions given on the instruction card accompanying each set when tuning.
6. Heterodyne between stations too close in frequency. This is no defect in the receiver and, therefore, cannot be remedied except by shifting the frequencies of the transmitters.

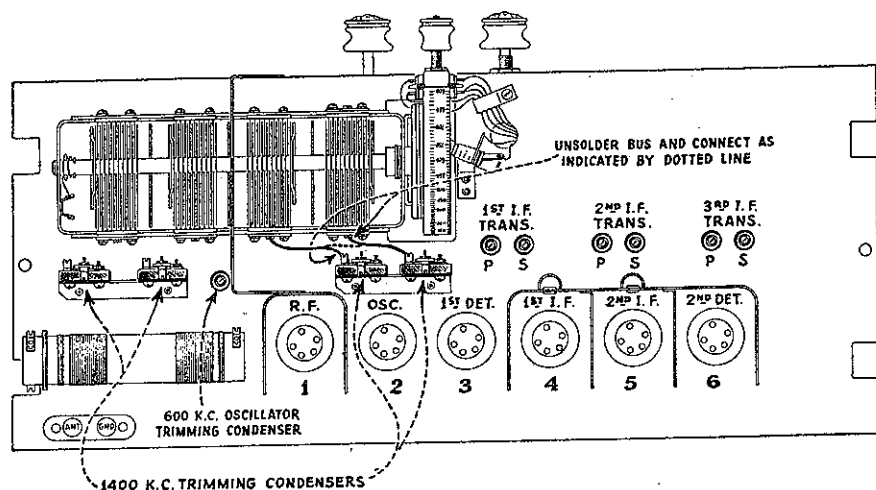
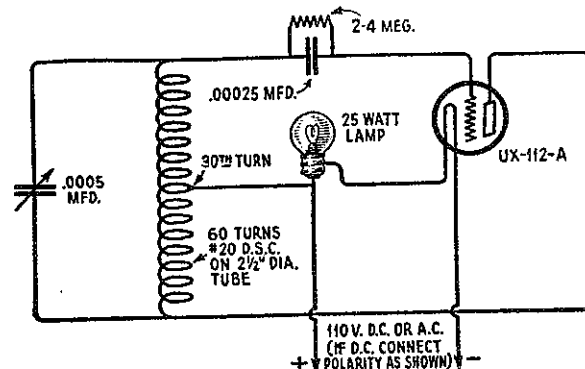


Figure 9



Modulated Oscillator

Figure 10

7. Strong local station. Set "Local-Distant" switch in "Local" position. Shift r-f tubes and first i-f tubes. Shorten antenna. Place a switch in antenna lead.
8. Open by-pass condensers or connections. Any failure that will cause a by-pass condenser not to function will result in distortion. Repair or replace any such defect.
9. Defect in Receiver Assembly or S.P.U. Check by means of continuity tests and make any replacement necessary.

AUDIO HOWL. Audio howl may be caused by:

1. Stations too close in frequency. This is a fault of the broadcasting transmitting stations and no fault of the receiver. Such a howl will be picked up on any type of receiver.
2. Open by-pass condensers. An open of any of the by-pass condensers may cause an audio howl.
3. Receiver Oscillation. An oscillating receiver will give a whistle when a station is tuned in.
4. Defective tubes in push-pull or detector stage. A defective tube in the push-pull or detector stage may cause the receiver to develop a howl. Replace any defective tube.
5. Vibrating elements in the receiver tubes. A gradually developed howl may be due to the loudspeaker, causing the receiver tube elements to vibrate.

OSCILLATION. Oscillation in the r-f and i-f stages may be due to:

1. Failure of shielding of the 224 tubes, or their control grid leads not in place. Make sure all shielding and leads are as originally intended. Any failure should be repaired.
2. Open by-pass condensers in receiver assembly. Test and make any repair or replacement necessary.
3. Lead from by-pass condenser not properly connected. A separate lead is brought out of the by-pass condenser case for the ground connection to the condenser that is connected to r-f and i-f plate voltage supply leads. While the condenser is still electrically in the circuit, if this lead is not connected, oscillation in the intermediate stages will result.
4. Defective 224 tube. A defective 224 tube may cause oscillation and should be replaced by a tube known to be in good operating condition.

ADJUSTMENT OF R-F LINE-UP AND OSCILLATOR TRIMMING CONDENSERS. Five adjustable condensers are provided for lining up the r-f circuits and shifting the oscillator frequency so that it will be at a 175 kc difference from the incoming r-f signal throughout the tuning range of the set. Poor quality, insensitivity and possible inoperation of the receiver may be caused by these condensers being out of adjustment.

If other adjustments have not been tampered with - the intermediate tuning and gang-condenser line-up condensers - the following procedure may be used for adjusting these condensers.

1. Procure an r-f oscillator giving a modulated signal at exactly 1400 kc and 600 kc. The General Radio Co., type 320 or 360 after calibration by G.R. Co., will be suitable or one may be

constructed by assembling and wiring the apparatus indicated in Figure 10. A non-metallic screw driver $1/4$ " in diameter is also necessary.

2. An output indicator is necessary. This may be a current squared galvanometer connected to the secondary of the output transformer instead of the cone coil of the reproducer unit, a 0-5 milliammeter connected in series with the plate supply to the second detector (lead No. 1) or the output devices included in the General Radio oscillators. In the type 320 the meter leads should be connected in the second detector plate circuit and in the type 360 across the cone coil connections of the loudspeaker. The cone coil may remain in place or be disconnected, satisfactory results being obtained in either case.
3. Locate the 600 kc trimming condenser, Figure 9, and turn the adjusting screw until it is about three-quarters of the way in. Set the "Local-Distant" switch at "Distant."
4. Set the oscillator in operation at exactly 1400 kc. Place the set in operation and tune in the signal. Make sure the receiver is properly grounded and has an average antenna. Adjust the volume control until a reading is obtained in the output meter. While making adjustments regulate the volume control so that an excessive reading is not obtained. Then adjust the selector knob until the scale reads 1400 kc. Now adjust the oscillator, 1st detector, r-f and line circuit trimming condensers in the order given until maximum output is obtained.
5. Set the oscillator at exactly 600 kc. Tune in the signal on the set and adjust the 600 kc oscillator trimming condenser, Figure 9, for maximum output while rocking the gang condenser back and forth. The dial scale should read exactly 600 kc. If it does not read 600 kc. loosen the screws that hold the scale and slip it until it reads one-half the error from 600 kc on the opposite side of 600 kc. For example, if the scale reads 620 kc. at maximum output set the scale at 590 kc. Another example would be if the scale read 580 kc to set it at 610 kc.
6. Shift the oscillator frequency to 1400 kc and set the selector scale at exactly 1400 kc. Now adjust the four trimming condensers in the order given under 4 until maximum output is obtained.
7. Place the oscillator again in operation at 600 kc and tune in the signal with the receiver. If adjustments have been properly made, the signal will be received at maximum output when the scale reads exactly 600 kc. If not, then the operations given under 5 and 6 must be again repeated.

With this adjustment so that the scale is exactly at 600 and 1400 all other dial readings will be correct within a very close limit.

ADJUSTMENT OF I-F TUNING CONDENSERS. Two screen-grid intermediate frequency amplifier stages are used in this set. Three transformers are necessary for coupling these two stages. Both the primary and secondary of each transformer is accurately tuned to 175 kc and the correct functioning of the receiver is dependent on the proper alignment of the i-f stages.

The first i-f transformer - the one in the copper container - has its two windings very loosely coupled, this condition being further accentuated by having a copper shield placed between each winding, which makes possible very sharp tuning of this first i-f stage unless the "Local-Distant" switch is in the local position and resistance is artificially added to the circuits. The other two transformers have their winding closely coupled - overcoupled - so that a broad top effect is obtained in the tuning curve. The reason for discussing the i-f curve is that this type of coupling has a bearing on the method to be used for lining up the i-f transformers. The second and third transformers being overcoupled, their tuning condensers are adjusted until a plus or minus equal frequency shift of the i-f oscillator frequency will give the same output and a flat top effect is obtained on the tuning curve. This is not the adjustment of the condensers that will give a maximum output and is a different procedure from that used in previous super-heterodyne receivers. The first transformer being closely coupled the tuning condensers are adjusted for maximum output.

A detailed procedure for making these adjustments follows:

A modulated r-f oscillator giving a signal at 175 kc and having a vernier condenser for shifting this frequency from 171 kc to 179 kc is necessary for aligning the i-f stages. The General Radio Co.'s type 360 oscillator gives this frequency variation, but calibration of these secondary points must be made on instruments purchased prior to June 1, 1930. On these earlier models and on the older General Radio type 320 oscillators to which the 175 kc frequency has been added, the General Radio Co. will add such calibrations, together with a 600 kc and 1400 kc calibration, at a nominal cost.

A non-metallic screw driver 1/4 inch in diameter is also necessary for making these adjustments. With the necessary equipment at hand, proceed as follows:

1. Place the set in such a position that access to all mechanism is obtained. Place the receiver in normal operation with the volume control at minimum and then remove the oscillator tube. (Socket No. 2.) Make sure a good ground connection has been made.
2. Connect output meter in circuit. The meter leads of the type 320 oscillator should be connected in series with lead No. 1 of the S.P.U. terminal strip. The type 360 output meter should be substituted for the cone coil of the reproducer unit and the switch on the oscillator set at "Dynamic."
3. Place the oscillator in operation at 175 kc and connect the coupling lead to the control grid connection of the second i-f tube (Socket No. 4.) If excessive output is obtained disconnect the coupling lead from the oscillator and place it a short distance away, but in such a position that will cause an indication in the output meter without causing the needle to go beyond the scale.

4. Adjust the secondary and then the primary (see Figure 9) of the third i-f transformer until a maximum reading is obtained in the output meter. After obtaining maximum output we know the two windings are closely adjusted to the same frequency. Now they must be readjusted until a flat top effect is obtained in the tuning curve. The flat portion should be at least 5 kc wide and generally will not exceed 7 kc in width. The method of doing this is to shift the oscillator frequency back and forth from 171 kc to 179 kc and noting, when the condensers are adjusted, that no appreciable change in output reading is obtained from 172.5 kc to 177.5 kc. Also the drop in output should be the same at 171 kc and 179 kc. This indicates that the flat top is centered at 175 kc. The usual method to obtain this characteristic is, after adjusting to maximum output, to adjust the capacity of the secondary condenser until the flat top effect is obtained. It will probably not be centered at 175 kc. It is, however, easy to shift its center point by increasing each condenser slightly to shift it to a lower frequency or decreasing both condensers slightly to increase its frequency. To make this adjustment the first time will be somewhat difficult, but after a little experience it is equally as easy as other super-heterodyne adjustments.

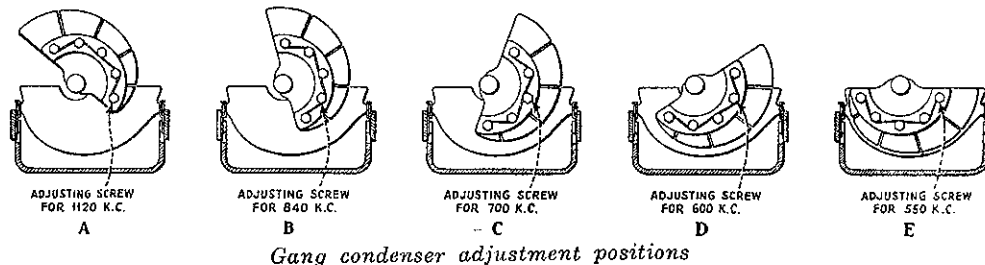


Figure 11

5. After adjusting the third i-f transformer, shift the coupling lead to the control grid connection of the 1st i-f tube and place it at a greater distance from the oscillator. Then advance the volume control to maximum. If necessary, reduce this coupling to an even greater extent so that too great an indication is not obtained in the output meter.
6. Now adjust the secondary and primary condensers until maximum output is obtained. Then readjust in the same manner as with the third transformer until a flat top effect is obtained. This may not be quite as broad as the third transformer.
7. If the "Local-Distant" switch is not already so adjusted, place it in the "Distant" position. Then shift the coupling lead to the control grid connection of the first detector (Socket No. 3). Now adjust the volume control until the meter reading is not excessive and then adjust the secondary and primary of the 1st i-f transformer condensers until maximum output is obtained. This transformer tunes very sharply and no further adjustments are necessary.

This completes the i-f tuning adjustments and when so made, the set will perform at maximum efficiency. However, it is best at this point to check the oscillator trimming and r-f line-up condenser adjustments.

LINE-UP ADJUSTMENTS OF GANG CONDENSER. The four-gang condenser used is a new type having features not found in similar condensers. The outstanding of these features are the steel construction and the adjusting screws provided for lining up each condenser in exact electrical alignment with all the other condensers. Five such screws are provided on each unit which allows five adjustments to be made, each of which is independent of the other adjustments. These adjustments are made at the factory and, unless tampered with, will not require any readjustments. If, however, adjustment is necessary a step-by-step procedure for making such adjustment follows:

1. Remove the receiver assembly from the cabinet. Procure a small socket wrench and a modulated oscillator (see Figure 10) covering the broadcast range. A 0-2 milliammeter is necessary to place in the first detector plate circuit. This may be done with an adapter that breaks the plate circuit of this tube, or by unsoldering the wire that is connected to the plate socket contact and connecting the meter to this lead and the socket contact. Remove the oscillator tube and connect a 20,000 ohm resistor from the oscillator socket plate connection to the cathode connection. Make a good ground connection to the receiver.

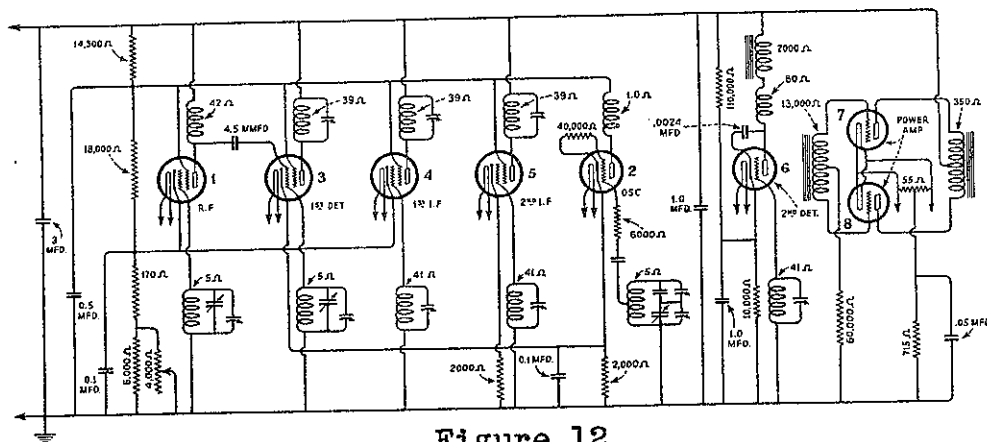


Figure 12

2. Place the receiver in operation and couple the oscillator to the antenna lead of the set. Turn the station selector knob until the first vanes of the gang condenser full mesh with the stator plates and the next set is free. This is shown in Figure 11-A. Now turn the screws on all the parallel trimming condensers until they are at their minimum capacity position.
3. Adjust the oscillator until a deflection is obtained in the milliammeter. This will be at about 1120 kc. If the condensers are accurately aligned, adjusting any of the screws that hold the first group of vanes in either direction of the link circuit, r-f circuit and first detector condenser will cause a decreased reading in the meter. If any, however, should cause an increased reading due to being pulled away from its adjacent plate - capacity reduced - then it should be adjusted for maximum output. If an

increased amount of capacity is required at any vane to increase the output, i.e. the vanes brought closer to the adjacent plate, then the oscillator should be increased in frequency slightly and the other two vanes readjusted. This would be a reduction in their capacity. The reason for this shift of frequency is to make sure that the condensers are aligned with the minimum capacity possible, as otherwise the dial scale may read inaccurately.

4. After aligning the link, r-f and first detector circuit, the bus bar indicated in Figure 9 should be shifted to the position indicated by the dotted line. The vanes on the oscillator condenser may now be shifted for maximum output.
5. Now shift the gang condenser so that the first and second sections are fully meshed with the stator plates. Shift the oscillator frequency until a deflection is obtained in the output meter and adjust the second group of vanes in the same manner as the first were adjusted. Shift the bus bar and adjust the first detector condenser also.
6. Follow this same procedure through until all the vanes have been adjusted. After their correct alignment the set must be realigned. If the i-f condensers require adjustment, they should be checked after the gang condenser adjustment has been made as just described and before the scale and oscillator condensers are adjusted.

DIAL SCALE NOT READING CORRECTLY. Should the dial scale give a large error in the indicated scale reading it may be due to any of the following:

1. Dial screen not in position. Sometimes the dial screen may slip slightly out of its position. Readjust at the low frequency end of the scale. It is readily accessible from the rear. Also check any possible bending of the dial lamp bracket.
2. Set not properly aligned.
3. Oscillator used for aligning not properly calibrated.

VOLTAGE SUPPLY SYSTEM. Figure 8 shows the voltage supply system and the values of current flowing in the different circuits together with the values of the various resistors. It will be noted that the series method of voltage supply is used except in the volume control circuit. This keeps the current drain on the rectifier tube at a minimum voltage.

VOLTAGE READINGS AT TERMINAL STRIP. The following voltages are taken at the S.P.U. terminal strip with a d-c and a-c voltmeter. The d-c meter should have a resistance of at least 1000 ohms per volt. Line voltage 120, fuse at 120-volt position, volume control at maximum.

Terminals	Volts
2 to 3	2.5 A.C.
4 to 5	250 D.C.

VOLTAGE READING SERVICE DATA CHART. The service data chart on sheet 21 provides a means of diagnosing trouble from socket voltage readings taken at the tube sockets with any of the usual set analyzers. These readings are average, and are not obtained with any particular test set.

VOLTAGE READINGS AT TUBE SOCKETS. The following voltages taken at each tube socket with the receiver in operating condition should prove of value when checking with test sets such as the Weston Model 547, Type 3, or others giving similar readings. The plate currents shown are not necessarily accurate for each tube, as the cable in the test set will cause some circuits to oscillate, due to its added capacity. Small variations of voltages will be caused by different tubes and line voltages. Therefore, the following values must be taken as approximately those that will be found under varying conditions. The numbers in column 1 indicate the tube socket numbers shown in Figure 6.

VOLTAGE READINGS AT TUBE SOCKETS

Tube No.	Cathode to Heater Volts D.C.	Cathode or Filament to Control Grid Volts, D.C.	Cathode to Screen Grid Volts, D.C.	Cathode or Filament to Plate Volts, D.C.	Plate Current M. A.	Heater or Filament Volts	Screen Grid Current M. A.
Volume Control at Maximum							
1	—34	— 2.2	80	240	3.2	2.2	.5
2	—22	—	—	60	6.5	2.2	—
3	—25	— 9.5	72	230	0.25	2.2	.1
4	—34	— 2.2	78	240	4.0	2.2	.5
5	—31.5	— 4.2	78	240	1.6	2.2	.5
6	—12	—22	—	212	0.25	2.2	—
7	—	—19*	—	200	25.0	2.2	—
8	—	—19*	—	200	25.0	2.2	—
Volume Control at Minimum							
1	—25	—10	75	230	0	2.2	0
2	—22	—	—	65	7.5	2.2	—
3	—25	—10	82	240	0	2.2	.1
4	—25	—10	75	230	0	2.2	0
5	—32	— 6	90	250	2.2	2.2	1.0
6	—12	—23	—	220	.0.25	2.2	—
7	—	—20*	—	210	28.0	2.2	—
8	—	—20*	—	210	28.0	2.2	—

*Not true reading due to resistor in circuit.

CONTINUITY TEST. The tests shown on sheets 23 and 24 will show complete continuity for the receiver assembly and socket power unit of this instrument. Disconnect the antenna and ground leads; the cable connections at the terminal strip of the S.P.U., and the a-c supply cord at its outlet.

A pair of headphones with at least $4\frac{1}{2}$ volts in series; or a voltmeter with sufficient battery to give a good deflection when connected across the battery terminals should be used in making these tests.

VOLTAGE READING SERVICE DATA CHART

Volume Control at Maximum

Local-Distant Switch at Distant

VOLTAGE CHARACTERISTIC	TUBE 1 (R.F.)		TUBE 2 (osc)		TUBE 3 (1st DET.)		TUBE 4 (I.F.)		TUBE 5 (I.F.)		TUBE 6 (2nd DET.)		TUBE 7 (A.F.)		TUBE 8 (A.F.)		Cause of Incorrect Readings									
	C.G. S.G. Plate	Plate	C.G. S.G. Plate	Plate	C.G. S.G. Plate	Plate	C.G. S.G. Plate	Plate	C.G. S.G. Plate	Plate	C.G. S.G. Plate	Plate	C.G. S.G. Plate	Plate	C.G. S.G. Plate	Plate										
	Volts	M.A.	Volts	M.A.	Volts	M.A.	Volts	M.A.	Volts	M.A.	Volts	M.A.	Volts	M.A.	Volts	M.A.										
Normal	2.2	90 240	4.0	70	6.0	8.0	80 235	2.5	2.2	85	240	5.5	5.0	85	240	3.0	20 200	30	Open volume control and 6000-ohm resistor, or open 170-ohm resistor							
High grid bias on tubes 1 and 3	138	0	110	0	100	10	32 130	250	0	137	0	105	0	13	130	255	3.0	26 235	1.0	Open grid coil of R.F. transformer						
No C.G. voltage on R.F. tube	0	85	245	5.0	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Open plate winding of R.F. tube						
Low plate voltage on R.F. tube	2.0	80	60	0	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Open 18,000-ohm resistor						
High S.G. voltage	2.4	120	245	6.0	85	8.0	26 110	230	25	22	110	240	6.5	65	105	240	3.0	...	Open grid coil of 1st detector							
No C.G. voltage on tube 3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Open secondary of 1st I.F. transformer						
No C.G. voltage on tube 4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Open secondary of 2nd I.F. transformer						
No C.G. voltage on tube 5	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Open secondary of 3rd I.F. transformer						
No grid voltage on tube 6	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Open Osc. plate coil						
High S.G. voltage and no Osc. volts or M.A.	3.2	115	240	5.0	0	6	115	235	2.5	3.5	110	240	6.0	7.0	110	235	3.0	...	Open primary of 1st I.F. transformer							
No plate volts or M.A. on tube 3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Open primary of 2nd I.F. transformer						
No plate volts or M.A. on tube 4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Open primary of 3rd I.F. transformer						
No plate volts or M.A. on tube 5	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Open 2nd Det. R.F. choke						
No plate volts or M.A. on tube 6	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Open 2000-ohm Osc. and 1st Det. bias resistor						
No Osc. or 1st Det. plate volts or M.A.	3.1	110	250	5.5	0	87	0	0	3.0	95	250	5.0	7.0	105	240	3.5	...	...	Open 2000-ohm 2nd I.F. bias resistor							
No plate volts and high grid volts on tube 6	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Open 10,000-ohm 2nd Det. bias resistor						
No voltages on tube 5	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Open 110,000-ohm resistor						
High 2nd Det. plate M.A.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Open 14,300-ohm resistor						
No C.G. or S.G. volts on tubes 1, 2, 3, 4 and 5; high 2nd Det. volts	0	300	0	0	0	0	0	300	0	0	300	0	0	300	0	20 280	0	...	...	Shorted 1 Mfd. condenser across volume control and 170-ohm resistor						
No C.G. volts on tubes 1 and 4	0	85	250	1.5	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Shorted .5 Mfd. condenser from S.G. supply to ground						
No C.G. or S.G. volts on tubes 1, 2, 3, 4 and 5	0	0	285	0	0	0	0	270	0	0	270	0	0	270	0	...	...	...	...	Shorted 1 Mfd. condenser from cathodes 2 and 3 to ground						
No C.G. volts on tube 3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Shorted 1 Mfd. condenser from cathode 5 to ground						
No C.G. volts on tube 5	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Shorted 1.0 Mfd. condenser from cathode 6 to ground						
All voltages low; no grid volts on tube 5	2.0	70	210	2.5	60	4.5	6.5	70	205	25	1.5	70	210	3.0	4.0	75	205	2.0	0	Shorted .0024 Mfd. condenser from plate to cathode tube 6						
High grid and no plate volts on tube 6	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Shorted .03 Mfd. condenser across 715-ohm bias resistor						
Low voltages; no grid volts on tubes 7 and 8	1.0	40	120	1.5	40	2.5	3.5	40	120	5	1.0	40	120	1.5	4.5	120	1.0	110	5	Open 715-ohm or 60,000-ohm grid resistor in S. P. U.						
High voltages on tubes 1, 2, 3, 4, 5 and 6	4.5	145	275	6.0	110	11.0	32	130	365	5	4.5	135	370	8.5	8.0	105	270	4.5	35	340	1.0	140	180	1.0	Shorted 60,000-ohm resistor	
High grid volts on tubes 7 and 8	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Open primary of inter-stage transformer						
No plate M.A. on tube 6	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Open one-half secondary of inter-stage transformer						
High plate current on tube 8	1.5	70	205	2.5	60	5.0	6.0	70	200	26	2.0	70	205	3.5	4.0	75	200	2.0	20	180	25	26	155	0	Open one-half primary of output transformer	
High plate current on tube 7	1.5	70	205	2.5	60	5.0	6.0	70	200	25	2.0	70	205	3.5	4.0	75	200	2.0	20	180	25	24	250	38	0	Open one-half primary of output transformer
No voltages on tube 8	3.0	100	270	5.0	75	6.5	9.0	90	250	26	3.0	95	260	6.5	6.0	95	260	3.0	26	230	25	24	250	38	0	Open one-half primary of output transformer
No voltages on tube 7	3.0	100	270	5.0	75	6.5	9.0	90	250	26	3.0	95	260	6.5	6.0	95	260	3.0	26	230	25	24	250	38	0	Open one-half primary of output transformer

*Caused by connection of meter from control grid to cathode.

The resistance of the various circuits are shown in the column titled "Correct Effect." Checking the resistance of the circuits adds an additional check on their correct functioning. This may be done by means of a direct reading "Ohmmeter," a resistance bridge, the voltmeter-ammeter method or the method suggested in the following paragraph. The receiver and S.P.U. tube sockets, numbers, lugs and terminals used in making these tests are shown in Figure 6. The receiver wiring diagram is shown in Figure 14 and the S.P.U. wiring diagram in Figure 15.

TESTING FILTER AND BY-PASS CONDENSERS. The filter and by-pass condensers are in metal containers. The internal wiring diagram is shown in Figures 14 and 15. The condensers can best be tested by charging them with approximately 200 volts d-c and then noting their ability to hold the charge. After charging, short circuiting the condenser terminals with a screw driver should produce a flash, the size of the flash depending on the capacity of the condenser and the voltage used for charging. A condenser that will not hold its charge, or a choke that clicks open is defective and requires replacement of the entire unit.

CHECKING RESISTANCE VALUES. The values of the various resistance units in this receiver are shown in the schematic diagrams in Figures 1 and 8. When testing a receiver for defects the various values of resistance should be checked. This may be done by a resistance bridge; the voltmeter-ammeter method, or by the following method.

For resistances of low value, 5000 ohms or less, use a voltmeter having a resistance not greater than 100 ohms per volt. For high values of resistance use a meter of 1000 ohms or more per volt. The Weston Meters, Type 301 or 280, each have a resistance of 62 ohms per volt and are satisfactory for the low values. Use sufficient battery to give a good deflection on the meter, for example, a 45-volt "B" battery for a 0-50 volt meter. Take two readings, one of the battery alone, and one of the battery with the unknown resistance in series. Then apply the following formula:

$$\left(\frac{\text{Reading obtained of battery alone}}{\text{Reading obtained with resistance in series}} \right)^{-1} \text{ Resistance of meter} = \frac{\text{Unknown}}{\text{Resistance}}$$

CALIBRATION OF R-F AND I-F OSCILLATORS. In servicing this receiver it is essential that the frequency of the i-f and r-f oscillators used for making adjustments be accurately known. Even with the best of material and construction oscillators will shift their frequency and a periodic check is both desirable and necessary.

I-F Oscillators

An easy way to check the frequency of the i-f oscillator is to check its fourth harmonic against a station operating at that harmonic frequency. In the case of the 175 kc oscillator used for this receiver the broadcasting station operating at this fourth harmonic frequency would be WLW, operating at 700 kc. The check is best made by tuning in the station accurately on a radio receiver and then setting the oscillator in operation coupled to the receiver antenna sufficiently so that it will be heard. Then adjust the i-f oscillator until the beat note between the fourth harmonic and WLW will

RECEIVER ASSEMBLY CONTINUITY TESTS

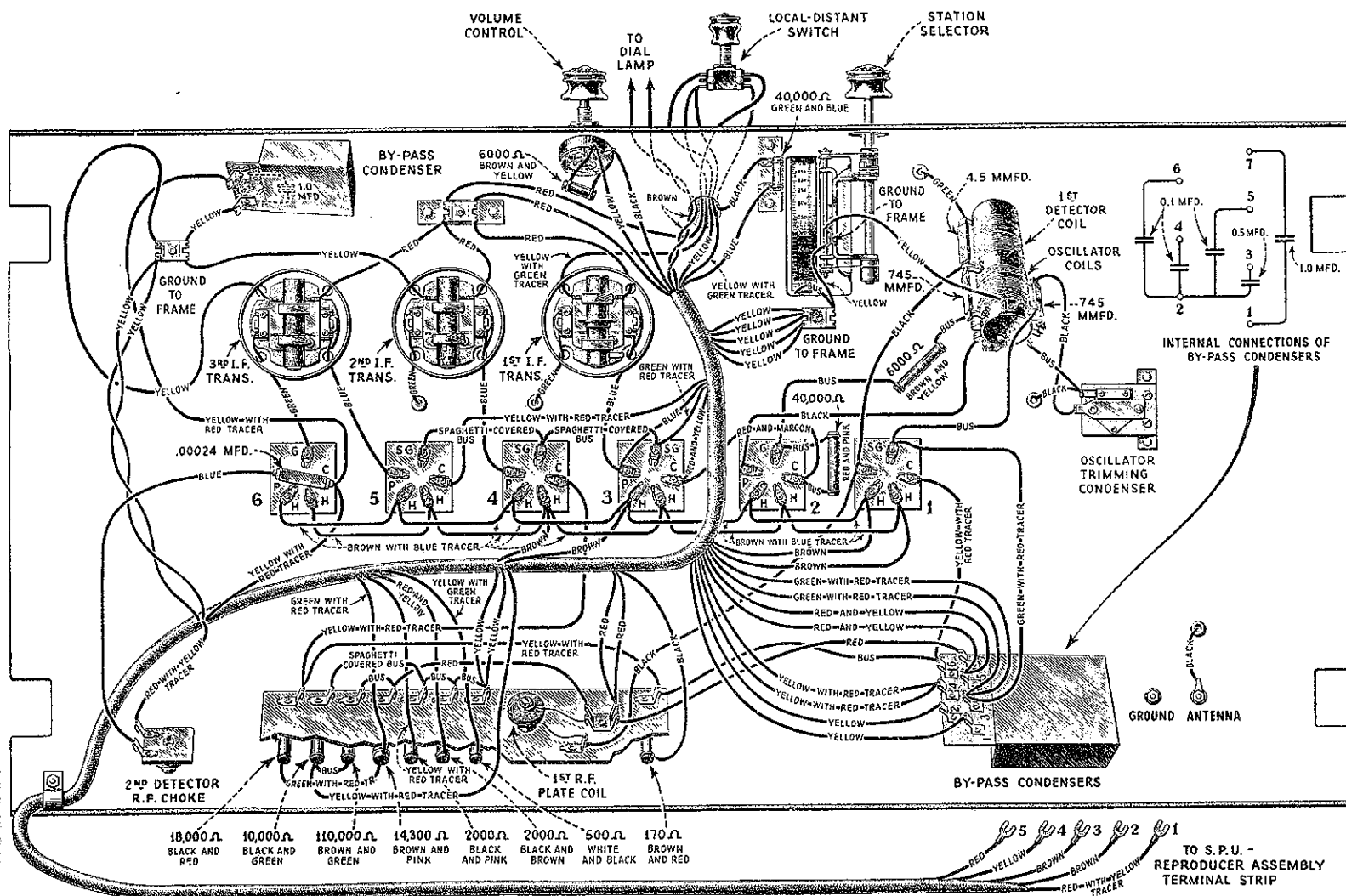
Terminals	Correct Effect	Incorrect Effect	
		Indication	Caused By
Ant. to Ground	Closed (40 ohms)	Open	Open antenna coupling coil
Stator tuning condenser No. 1 (See Figure 7) to Ground	Closed (5 ohms)	Open Short	Open link circuit coil Shorted link circuit tuning or trimming condenser
C1 and C4 to Ground	Closed (V.C. at Min.) 4170 ohms	Open Short	Open 170 ohm resistor or volume control Shorted .1 mfd. condenser
CG1 to Ground	Closed (5 ohms)	Open Short	Open R.F. grid coil Shorted R.F. tuning or trimming condenser
SG1, 3, 4, and 5 to Ground	Closed (V.C. at Min.) (22,170 ohms)	Open 18,000 ohms Short	Open 18,000 ohms, 170 ohm resistor or volume control Shorted .1 mfd. condenser Shorted .5 mfd. condenser
P1 to Lug No. 5	Closed (42 ohms)	Open	Open R.F. plate coil
G2 to Ground	Closed (42,000 ohms)	Closed (6000 ohms) 40,000 ohms Open Short	Shorted 720 mmfd. oscillator grid condenser Shorted .1 mfd condenser Open 40,000 or 2000 ohm resistor Grounded 6000 or 40,000 ohm resistor
P2 to SG1	Closed (1 ohm)	Open	Open oscillator plate coil
C2 and C3 to Ground	Closed (2000 ohms)	Open Short	Open 2000 ohm resistor Shorted .1 mfd. condenser
P3 to Lug No. 5	Closed (39 ohms)	Open Short	Open primary of 1st I.F. transformer Shorted 1st I.F. primary tuning condenser
CG4 to Ground	Closed (41 ohms)	Open Short (Local-Distant at "distant")	Open secondary of 1st I.F. transformer Shorted 1st I.F. secondary tuning condenser
P4 to Lug No. 5	Closed (39 ohms)	Open Short	Open primary of 2nd I.F. transformer Shorted 2nd I.F. transformer tuning condenser
CG5 to Ground	Closed (41 ohms)	Open Short	Open secondary of 2nd I.F. transformer Shorted 2nd I.F. transformer tuning condenser
C5 to Ground	Closed (2000 ohms)	Open Short	Open 2000 ohm resistor Shorted .1 mfd. condenser
P5 to Lug No. 5	Closed (39 ohms)	Open Short	Open primary of 3rd I.F. transformer Shorted 3rd I.F. transformer primary tuning condenser
SG5 to Lug No. 5	Closed (14,300 ohms)	Open	Open 14,300 ohm resistor

RECEIVER ASSEMBLY CONTINUITY TESTS—Continued

Terminals	Correct Effect	Incorrect Effect	
		Indication	Caused By
C6 to Ground	Closed (10,000 ohms)	Open	Open 10,000 ohm resistor
G6 to Ground	Closed (41 ohms)	Open	Open secondary of 3rd I.F. transformer
C6 to P6	Open	Closed	Shorted .0024 mfd. condenser
P6 to Lug No. 1	Closed (80 ohms)	Open	Open R.F. choke coil
Lug No. 2 to one heater contact of all sockets. (Remove dial lamp)	Closed	Open	Open heater connection
Lug No. 3 to other heater contact of all sockets. (Remove dial lamp)	Closed	Open	Open heater connection

S.P.U. REPRODUCER CONTINUITY TESTS

Terminals	Correct Effect	Incorrect Effect	
		Indication	Caused By
Across filament contacts of sockets 7 or 8	Closed	Open 55 ohms	Open filament winding and center tapped resistor Open filament winding
Either filament contact of sockets 7 or 8 to Ground	Closed (715 ohms)	Open Short	Open UX-245 grid bias resistor Shorted .05 mfd. condenser
G7 to G8	Closed (13,000 ohms)	Open	Open secondary of push-pull input transformer
G7 or G8 to Ground	Closed (66,500 ohms)	Open	Open secondary of push-pull input transformer or 60,000-ohm resistor
Terminal 1 to Terminal 5	Closed (1,900 ohms)	Open 40,000 ohms	Open primary of push-pull input transformer 40,000-ohm resistor Open primary of push-pull input transformer
P7 to P8	Closed (350 ohms)	Open	Open primary of output transformer
P7 or P8 to Terminal No. 5	Closed (175 ohms)	Open	Open primary of output transformer or center tap connection
Across cone coil (unsolder leads)	Closed (10 ohms)	Open	Open cone coil
Across output leads to terminal strip (cone coil disconnected)	Closed (.8 ohms)	Open	Open secondary of output transformer
Across UX-280 filament contacts	Closed	Open	Open UX-280 filament winding
P to P of UX-280 socket	Closed (350 ohms)	Open	Open high voltage winding of power transformer
Either P of UX-280 socket to Ground	Closed (1890 ohms)	Open	Open high voltage winding of power transformer, filter reactor or field of reproducer unit
Across A.C. input plug	Closed (3.5 ohms) (Operating switch "on")	Open	Open primary of power transformer or fuse



Wiring diagram of receiver assembly

Figure 13

approach zero frequency (zero beat). At this point both the transmitting station and the harmonic of the oscillator are at the same frequency. The fundamental must therefore be at one-fourth of the frequency, or 175 kc.

An interesting point in connection with this check is that the eighth harmonic of 175 kc is 1400 kc. This check on the i-f frequency will therefore serve as an additional check on the 1400 kc position by tuning in this harmonic on a receiver.

R-F Oscillators

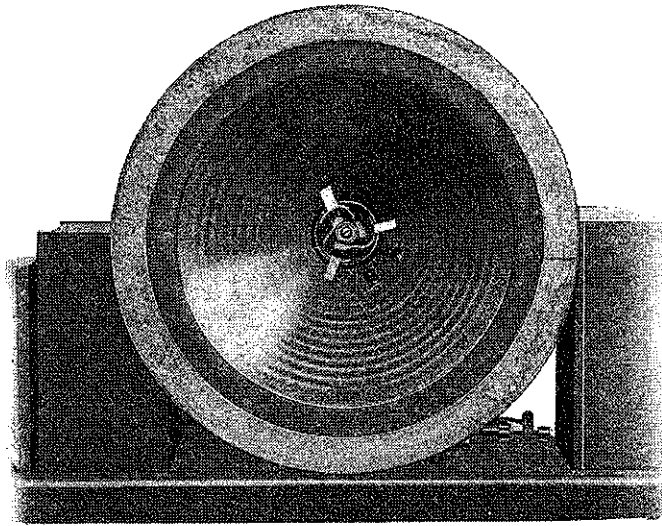
The r-f oscillator may be calibrated in the same manner as the i-f oscillator with the exception that its fundamental frequency should beat against numerous broadcasting stations and a curve plotted so that all frequencies will be known. Such a curve is shown in Figure 15. As the dial of the receiver is adjusted at both 1400 kc and 600 kc it is very important that these two places on an oscillator used for that work be accurately known. A step-by-step procedure for making such a calibration follows:

- [illegible]

Lesson 45 - sheet 26

REPLACING REPRODUCER CONE. Should replacement of the reproducer cone be necessary, proceed as follows:

1. Remove the S.P.U. Reproducer assembly as described in the foregoing.
2. Remove the felt ring glued to the front of the reproducer unit.
3. Remove the nine nuts, screws and lock washers that hold the metal ring and cone edge in place. Remove the cone centering screw. The cone coil is connected by means of two soldered terminals located adjacent to the cone bracket. Unsolder these leads. The cone may now be removed.
4. Place the new cone in the position occupied by the old one, and replace cone ring, the nine screws, nuts and the lock washers. Do not tighten these screws.
5. Place three pieces of cardboard the thickness of a visiting card and approximately $1\frac{1}{2} \times \frac{1}{4}$ inches in size in the space between the inside of the cone coil and the pole piece. This is shown in Figure 17.
6. Now replace the cone centering screws and screw in place tightly.
7. Tighten the nine screws that hold the cone edge and replace the felt ring.
8. Solder the cone coil leads in place.



View showing loudspeaker adjusting strips

Figure 17.

EXAMINATION - LESSON 45

1. (a) How would you test a by-pass condenser? (b) A filter condenser?
2. What comprises the "tuned" circuit in these receivers and what purpose does it serve?
3. What is the advantage of the "Local-Distant" switch?
4. How may very loud signal strength from near-by powerful stations be reduced?
5. What is likely to be the result of a defective detector tube?
6. If the five adjustable condensers are out of adjustment what likely will be the result?
7. If any of the by-pass condensers in the receiver assembly are "open" what will be the result?
8. What will be the result of a grounded filament lead?
9. What are the noticeable effects of a microphonic detector tube?
10. What is the purpose of the second detector?